



# Instructions

Scrolling through a two-column document on-screen from the bottom of one column to the top of the next, and so on, can get very tedious.  Fortunately, "column threading" is automatic with this software. Here are the basic tools and techniques that you need to know to efficiently navigate through the columns in this document ...



1. Click on the hand tool in the button bar. 

2. Whenever the hand cursor is positioned over a column, the cursor changes to the "read article cursor",  and "Read Article" appears in the status bar to indicate that this text is part of an "article". *An article is a collection of columns selected by the editor that comprise one subject, like one of the articles on the front page of a newspaper. Each first-level section (1.1, 1.2, 1.3...) of the NTIA Manual has been defined as a separate article.* Click any part of the article to start reading at that point, or control-click to start at the beginning of the article. The cursor now changes to the follow-article cursor, and "Follow Article" appears in the status bar.



3. To page down, simply click the mouse, or use the scrollbar, or press the PageDown key. *You can keep track of where you are on the page if you're using the thumbnails-and-page view. In this view a selection rectangle moves over a thumbnail of the page as you scroll through the columns in the page view window.*



4. You can continue to click until you reach the end of the article. At the end of the article, the cursor changes to the end-article cursor, and "End Article" appears in the status bar. Click again to return to the page view displayed before you started reading the article. Click the fit page button.


5. If you want to exit before the end of the article...

- select any navigation method (but not Enter or Return)
- Go to another article or page
- Hold down Shift + Ctrl and click.



6. You can also select which article (NTIA Manual Section) to view by choosing “Articles...” from the View menu, and then selecting the article you want from the dialog box that appears. *You can keep* this dialog box displayed so you can go from one article to another, or better yet, use the bookmarks method described in #7 below.

7. The **best way** to select which article (NTIA Manual Section) to view is to switch to the “Bookmarks-and-Page” view, click  on the section name bookmark, **click with the hand cursor on the page**, then navigate with the hand tool as described in #1-5 above. Links to all of the sections are provided — as well as links to tables, figures, endnotes, and even these instructions.

8. To select text within a column, click the text selection tool, hold down the Control key, and drag to select the text you want to copy. 

## ANNEX M

## Measurement Methods

### 1.1 GENERAL

#### 1.1.1 Introduction

Chapter 5 of this Manual contains Radio Frequency Spectrum Standards applicable to Federal radio stations and systems. This Annex supplements Chapter 5 with the measurement methods appropriately referenced from the various sections of Chapter 5. A measurement method, in turn, is referenced back to Chapter 5. Cross-references to the FCC CFR and/or other measurement method procedures are also provided in this annex..

#### 1.1.2 Measurement Methods

Measurement methods included or referenced in this annex are provided only for clarification and uniform interpretation of the standards. In cases of harmful interference, the agencies involved are expected to utilize these or equivalent, mutually agreed upon, methods of measurement for resolution of any disagreement concerning compliance with the standards. Agencies may, at their discretion, use these measurement methods as minimum qualification test procedures, e.g., as part of factory test procedures.

NTIA standards are available for purchase from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Electronic Industries Association and Telecommunications Industry Association (EIA/TIA) standards may be obtained by calling Global Engineering Documents (1-800-854-7179).

#### 1.1.3 Resolution Bandwidth

Resolution bandwidth is the 3 dB bandwidth of the measurement system used, e.g., in power spectral density measurements. The appropriate resolution bandwidth of the measurement system varies depending on the modulation type and frequency band but should not be greater than the necessary

bandwidth of the transmitter being measured.

### 2.1 MEASUREMENT METHODS

#### 2.1.1 FIXED AND MOBILE SERVICES

##### A. Fixed and Mobile Single Sideband and Independent Sideband Equipments (2 - 29.7 MHz)

This measurement method is referenced from Section 5.3.1. For HF single sideband transmitters, the transmitter without a device to limit modulation or peak envelope power shall be modulated as follows. The input level of the modulating signal shall be that necessary to produce rated peak envelope power. HF single sideband transmitters in J3E, H3E, or R3E emission modes shall be modulated by two tones at frequencies on 400 Hz and 1800 Hz (for 3.0 kHz authorized bandwidth), applied simultaneously. The input levels of the tones shall be so adjusted that the two principal frequency components of the radio frequency signal produced are equal in magnitude and 3 dB below the maximum received signal level (RSL) as indicated in Figure 5.3.1 of Chapter 5. The plot of the spectrum shall have a span of 21.1 kHz or that necessary to identify intermodulation products up through the 13th and a resolution bandwidth of 100 Hz. This measurement method is also contained in Title 47 CFR Section 2.989 (d)(2).

##### B. Maritime Mobile, FM Operation (150.8 - 162.0125 MHz)

This measurement method is referenced from Section 5.3.2, see Note (q). The Measurement method for frequency tolerances to be used is as given in the Electronic Industries Association (EIA) Standard TIA/EIA-603, *Land Mobile FM or PM Communications Equipment Measurement and Performance Standards* (ANSI/TIA/EIA-603-92), Chapters 2, 3 and 4, or equivalent.

### **C. Fixed Services (406.1 - 420 MHz, 932 - 935/941 - 944 MHz, and 1.71 - 15.35 GHz)**

#### **1. Transmitter Standards**

(a) Measurement Method for Frequency Tolerance of Transmitter (referenced from Section 5.2.1, see Note (u)): A sample of the unmodulated carrier at the center frequency should be measured with equipment having an accuracy of at least five times that of the minimum to be measured.

(b) Measurement Method for Unwanted Emissions of Transmitters Employing Digital Modulation Techniques (referenced from Section 5.5.3): A sample of the transmitter output at the interface point with the antenna transmission line shall be measured using a measurement system with 4 kHz resolution bandwidth. The full unmodulated carrier power output is used as the transmitter average output reference.

Measurement of the unwanted emissions shall be made from the lowest radio frequency generated by the equipment to the third harmonic of the carrier with the transmitter modulated as follows:

(1.) Analog-white noise generator in accordance with EIA RS-252A recommended loading levels.

(2.) Digital-pseudorandom code generator with appropriate loading levels and format.

#### **2. Receiver Standards.**

(a) Receiver Intermediate Frequency (IF) Measurement Method, (referenced from Section 5.3.3): The IF shall be measured with equipment having an accuracy of at least five times greater than the frequency tolerance to be measured. The measurement shall be made with an unmodulated input signal on the assigned frequency coupled to the input of the receiver at a level greater than 20 dB above the receiver ambient noise.

(b) Receiver Unwanted Signals Measurement Method, (referenced from Section 5.3.3): Couple two signal generators to the input of the receiver and connect a spectrum analyzer to the baseband output. The unmodulated output of one signal generator (desired signal) on the assigned frequency shall be adjusted to reduce the baseband

noise by 3 dB as observed on the spectrum analyzer. The unmodulated output of the second signal generator (unwanted signals) shall be adjusted to 70 dB above that of the desired signal. The output frequency of the unwanted signals shall be varied over a range of  $\pm 1$  percent of the assigned frequency excluding frequencies within the receiver 60 dB selectivity bandwidth.

At each receiver response of the unwanted frequency, adjust the output of the unwanted signal generator for a 3 dB reduction in baseband noise. The difference, expressed in dB, in the output levels of the two signal generators is the unwanted signal attenuation.

### **D. Land Mobile, Single Channel Narrowband Operations (220 - 222 MHz)**

This measurement method is referenced from 5.3.4. A sample of the unmodulated carrier at the center frequency should be measured with equipment having an accuracy of at least five times that of the minimum to be measured.

Measurement Method for Resolution Bandwidth. The resolution bandwidth of the instrumentation used to measure the emission power shall be 100 Hz for measuring emissions up to and including 250 kHz from the edge of the authorized bandwidth, and 10 kHz for measuring emissions more than 250 kHz from the edge of the authorized bandwidth. If a video filter is used, its bandwidth shall not be less than the resolution bandwidth. The power level of the highest emission within the channel to which the attenuation is referenced shall be remeasured for each change in resolution bandwidth.

Additional guidelines may be obtained from the latest revision of Electronic Industries Association (EIA) TSB-57, *Sideband Spectrum Measurement Procedure for Transmitters Intended for Use in the 220-222 MHz Band*. Modulation is referenced to FCC regulations (CFR 47 2.989).

### **E. Analog or Digital FM/PM Operations**

#### **1. Wideband (29.7 - 50, 162 - 174, and 406.1 - 420 MHz)**

(a) Measurement Methods for Transmitter Frequency Deviation and Receiver Conducted

Spurious Emissions, All Station Classes and Bands, (referenced from Section 5.3.5.1): The prescribed measurement methods to be used are given in the latest revision of Electronic Industries Association (EIA) Standard TIA/EIA-603, *Land Mobile FM or PM Communications Equipment Measurement and Performance Standards* (ANSI/TIA/EIA-603-92), Chapters 2, 3 and 4.

The present EIA measurement methods were written for analog systems. Some of these methods are not appropriate for digital systems. Appropriate analog to digital or digital to analog test sets will have to be used.

(b) Measurement Method for Frequency Tolerance, (referenced from Section 5.2.1, see Note (i)): An unmodulated standard input signal source, adjusted to the standard input frequency as specified in the latest revision of Electronic Industries Association (EIA) Standard RS-204, *Minimum Standards for Land Mobile Communications FM or PM Transmitter, 25 - 866 MHz* shall be connected to the receiver under test and adjusted for an output of 20 dB above the receiver sensitivity. The center frequency of the IF passband shall be measured with equipment having a degree of accuracy of at least five times the minimum tolerance to be measured.

2. Narrowband (138 - 150.8, 162 - 174, and 406.1 - 420 MHz Bands)

Transmitter and Receiver Measurement Methods (referenced from Section 5.3.5.2): The measurement methods to be used are as given in the Telecommunications Industries Association (TIA) standard TIA/EIA-603 for F3E emission equipment, and Telecommunications Systems Bulletin TIA/EIA TSB102.CAA for F1D or F1E emission equipment as adopted by NTIA. Where these methods are not specified for a particular system type, appropriate test procedures should be applied.

The present EIA measurement methods were written for analog systems. Some of these methods are not appropriate for digital systems. Appropriate analog-to-digital or digital- to-analog test sets will have to be used.

## 2.1.2 Radar Spectrum Engineering Criteria (RSEC)

### A. General including RSEC-A

This measurement method is referenced from Section 5.5.1. NTIA Report 84-157 (NTIS Accession No. PB 85-119022), *Measurement Procedures for the Radar Spectrum Engineering Criteria*, August 1984, presents one or more test procedures(s) for each of the equipment parameters covered by RSEC that will yield adequate measured data for checking against the RSEC. These test procedures are not meant to replace any existing agency radar measurement procedures

### B. RSEC B

This measurement method is referenced from Section 5.5.2. In order to coordinate radar operations in the field, an accurate measurement of the operating frequency is necessary. An accuracy of 1 ppm is desirable, although, for most radars 100 ppm is adequate. Of comparable importance is the capability to measure pulse rise time and spectrum occupancy. Accordingly, each Government agency shall have access to the instrumentation necessary to make a frequency measurement to at least 100 ppm and suitable oscilloscopes and spectrum analyzers to measure time and frequency parameters necessary to determine conformance with these criteria. For fast rise devices, such as magnetrons, oscilloscopes with bandwidths of at least 50 MHz should be used.

### C. RSEC C and RSEC D

This measurement method is referenced from Sections 5.5.3 and 5.5.4. In order to coordinate radar operations in the field, an accurate measurement of the operating frequency is necessary. An accuracy of 100 ppm is adequate. Of comparable importance is the capability to measure pulse rise time and spectrum occupancy. Accordingly, each Government agency shall have access to the instrumentation necessary to make a frequency measurement to at least 100 ppm and suitable oscilloscopes and spectrum analyzers to measure time and frequency parameters necessary to determine conformance with these criteria. For fast

rise devices, such as magnetrons, oscilloscopes with bandwidths of at least 50 MHz should be used.

#### **D. RSEC E**

This measurement method is referenced from Section 5.5.5. In order to coordinate radar operations in the field, an accurate measurement of the operating frequency is necessary. An accuracy of 1 ppm is adequate. Of comparable importance is the capability to measure pulse rise time and spectrum occupancy. Accordingly, each Government agency shall have

access to the instrumentation necessary to make a frequency measurement to at least 1 ppm and suitable oscilloscopes and spectrum analyzers to measure time and frequency parameters necessary to determine conformance with these criteria. Measurement instruments shall have resolution bandwidths of at least 10 kHz to measure close in bandwidth limits, and otherwise 100 kHz bandwidth below 1 GHz and 1 MHz bandwidth at and above 1 GHz should be used.

**(Last page in Annex M)**